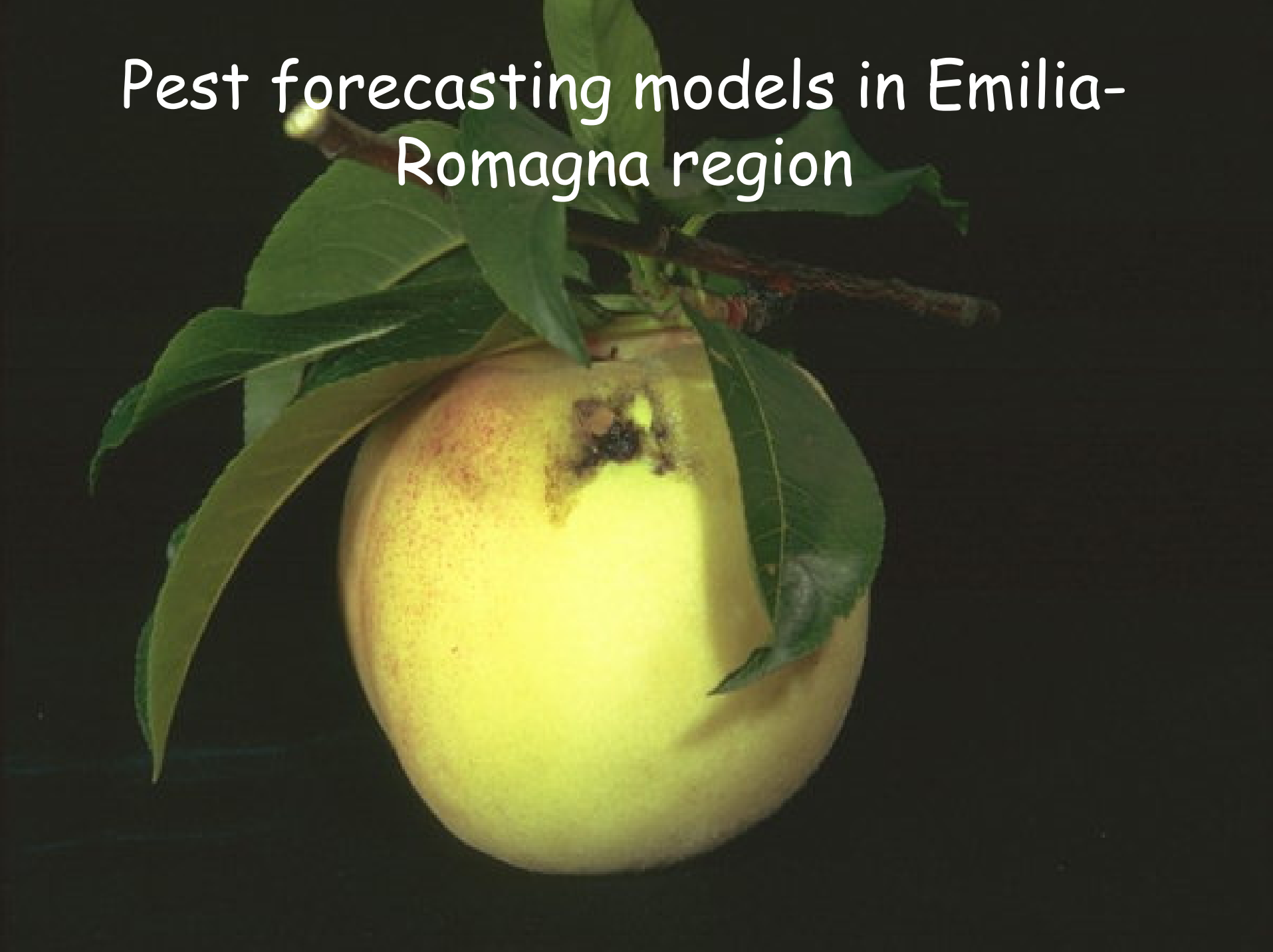
Pest forecasting models in Emilia-Romagna region



HOW TO OPTIMIZE PLANT PROTECTION PROGRAMME

- ✔ Demographic estimates — Pheromone traps, field surveys

Is it necessary to spray ?

- ✔ Age-structure of pest population — Simulation model

When to spray ?

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Pest control strategy

- Verify the pest action threshold overcome by field survey

- Take into account the model simulation in the area (in particular, the presence of the pest at the sensitive age)

- Choose the most useful PPP on the bases of specific efficacy, mode of action, safety period etc.

Time distributed delay model - MRV

Plant protection service - Emilia-Romagna

Lobesia botrana

Cydia pomonella

Cydia molesta

Pandemis cerasana

Argyrotaenia pulchellana

Cydia funebrana

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Contributions to set up MRV models

◆ mathematical theory	Manetsch (1976)
◆ ecology applications	Welch et al. (1978) Gutierrez et al. (1984)
◆ algorithm	Baümgartner e Severini (1987)
◆ biological parameters and validations	Briolini, Tiso, Butturini, De Berardinis (1990-1997)

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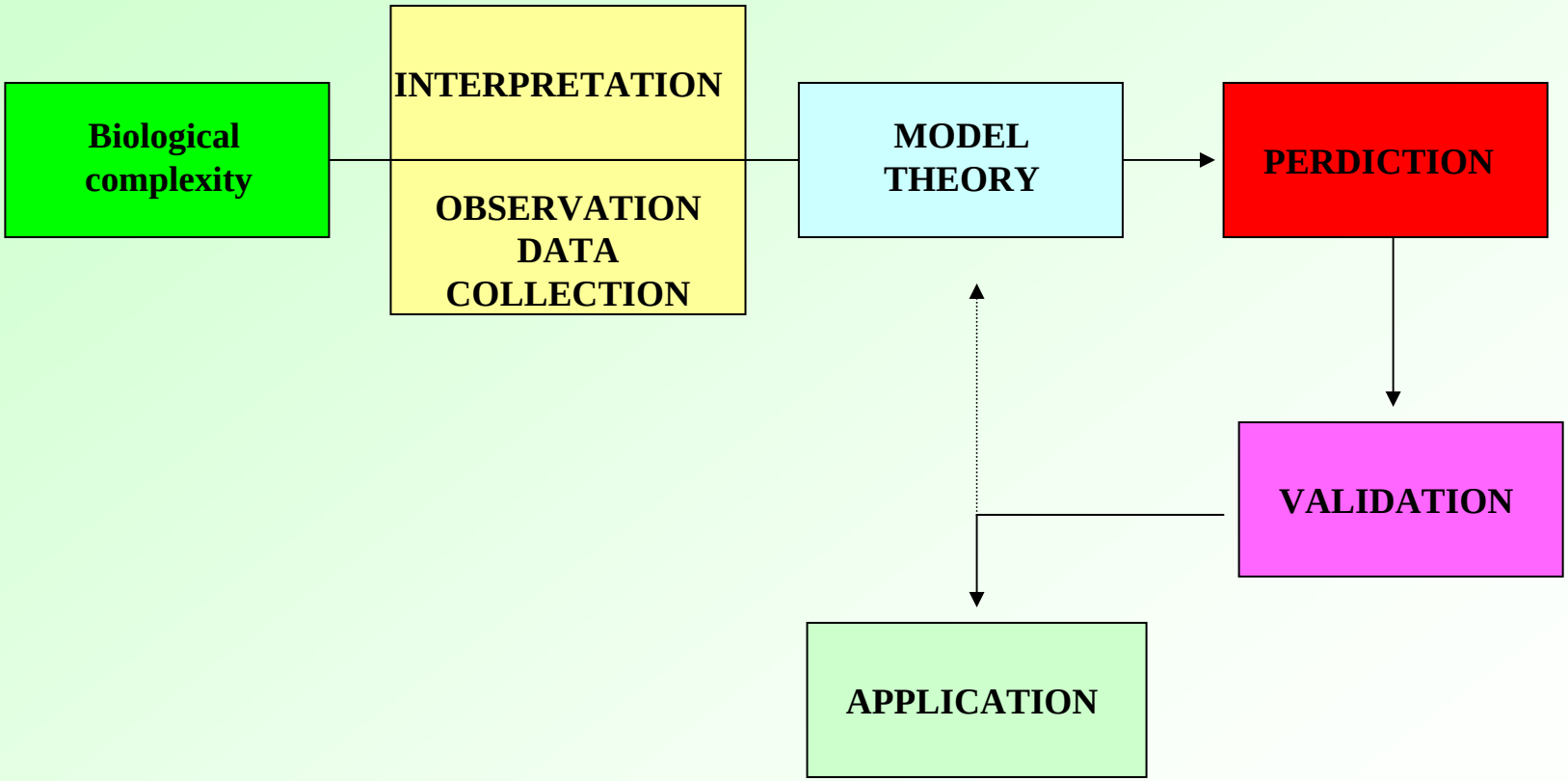
A Simulation model describes, by means of mathematic equations, the relationship between a biologic event and one or more climate parameters

BUILD-UP	Introduction of simplification theories
VALIDATION	Comparison between expected and observed data

MODEL BUILD_UP



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SIMULATION MODELS

phenological

The output is the date when a phenological event occurs (i.e. egg-hatching)

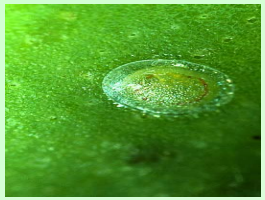
Time-distributed Delay (MRV)

It describes the age-class distribution (i.e.: percentage of individuals belonging to each stage for a specific day)

demographic

The output is a number (i.e.: the number of individuals of a population for a specific day)

SIMULATION MODEL MRV

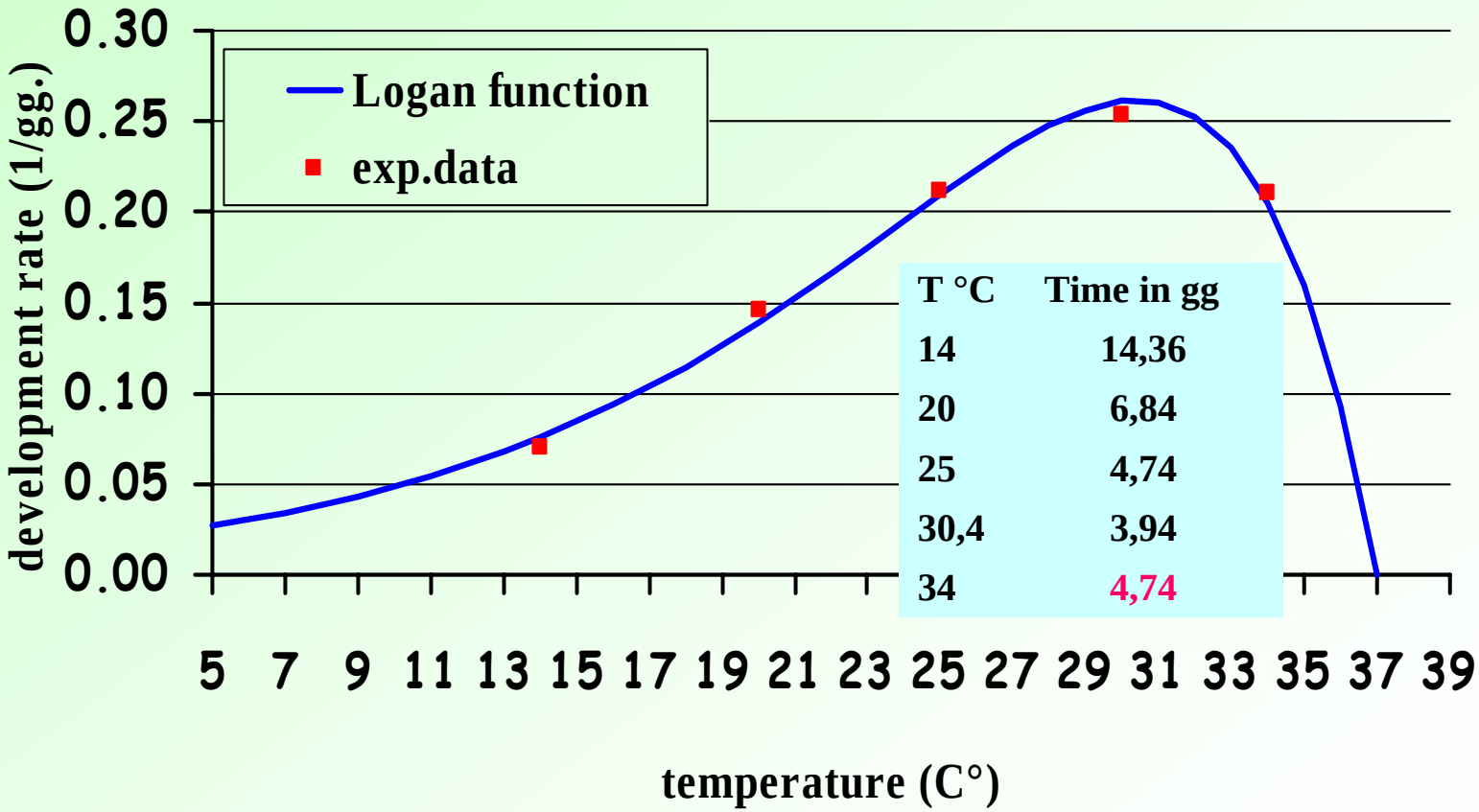



• The development of insects from a phenological phase to the the other depends on temperature

• Mathematical equation describing the pest development in relation to the temperature depends on features of the species (phenological phase) and it has to be experimentally calculated.

Temperature-related Egg developmental rate of *Cydia funebrana*

F(x) = P1(exp(P2(x-Tli))-exp(P2(Tll-Tli)-P3(Tll-x)))



T °C	Time in gg
14	14,36
20	6,84
25	4,74
30,4	3,94
34	4,74

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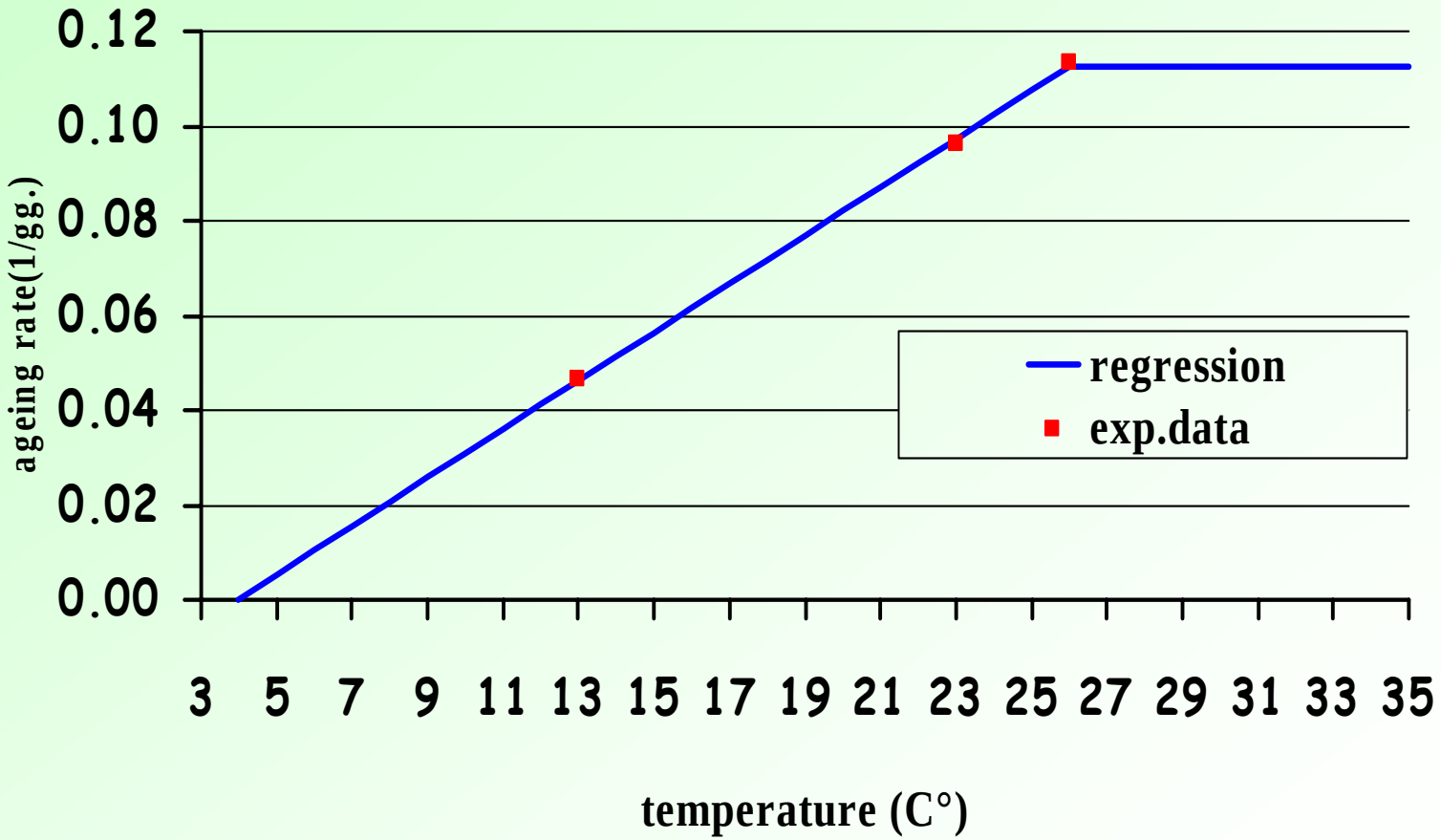
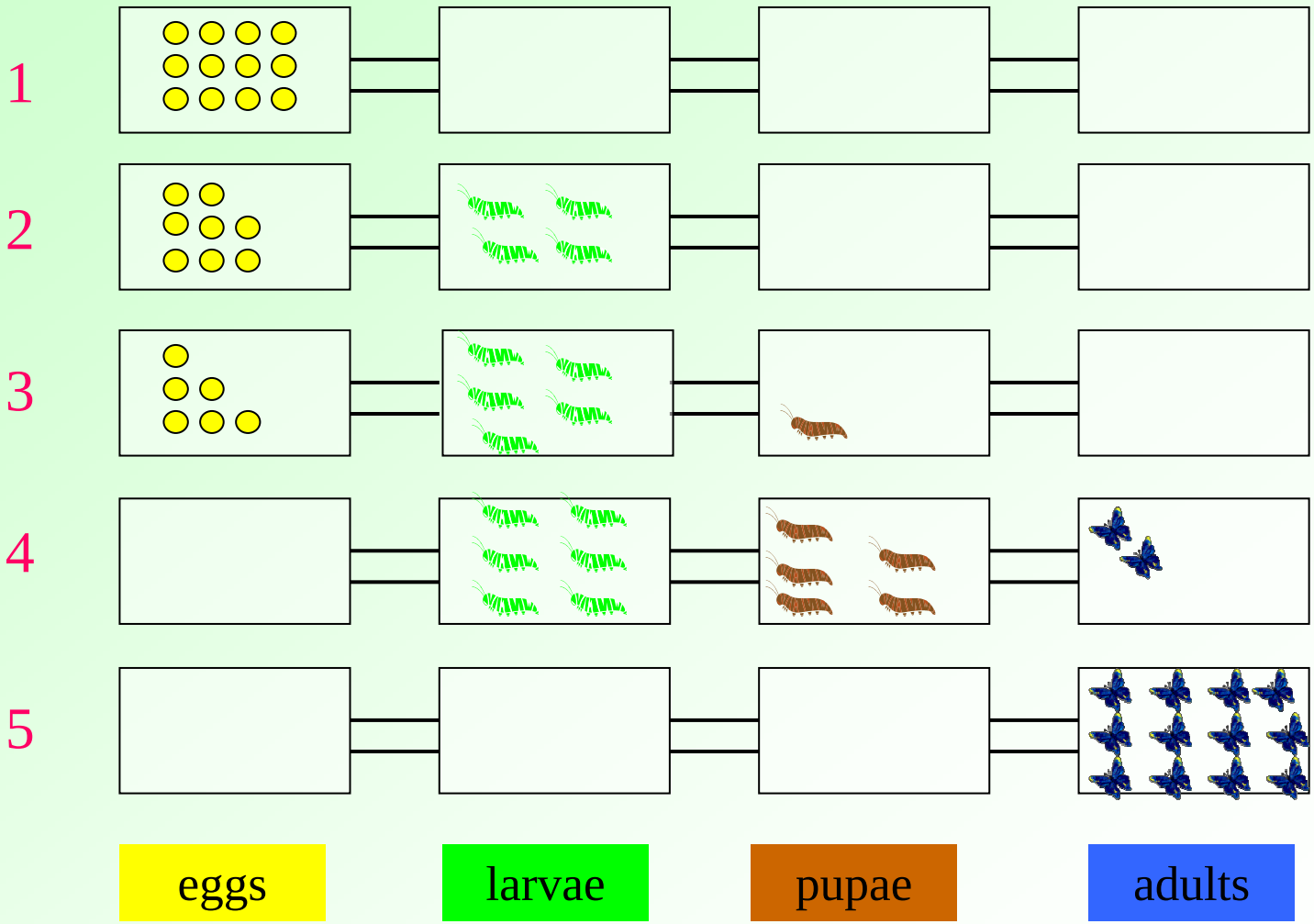
Temperature-related Female ageing rate of *Argyrotaenia pulchellana*



Time Delay Simulation Model

Individual of the same population pass through the same phenological phase (egg, larvae, …) in different time (0, 1, 2, …)



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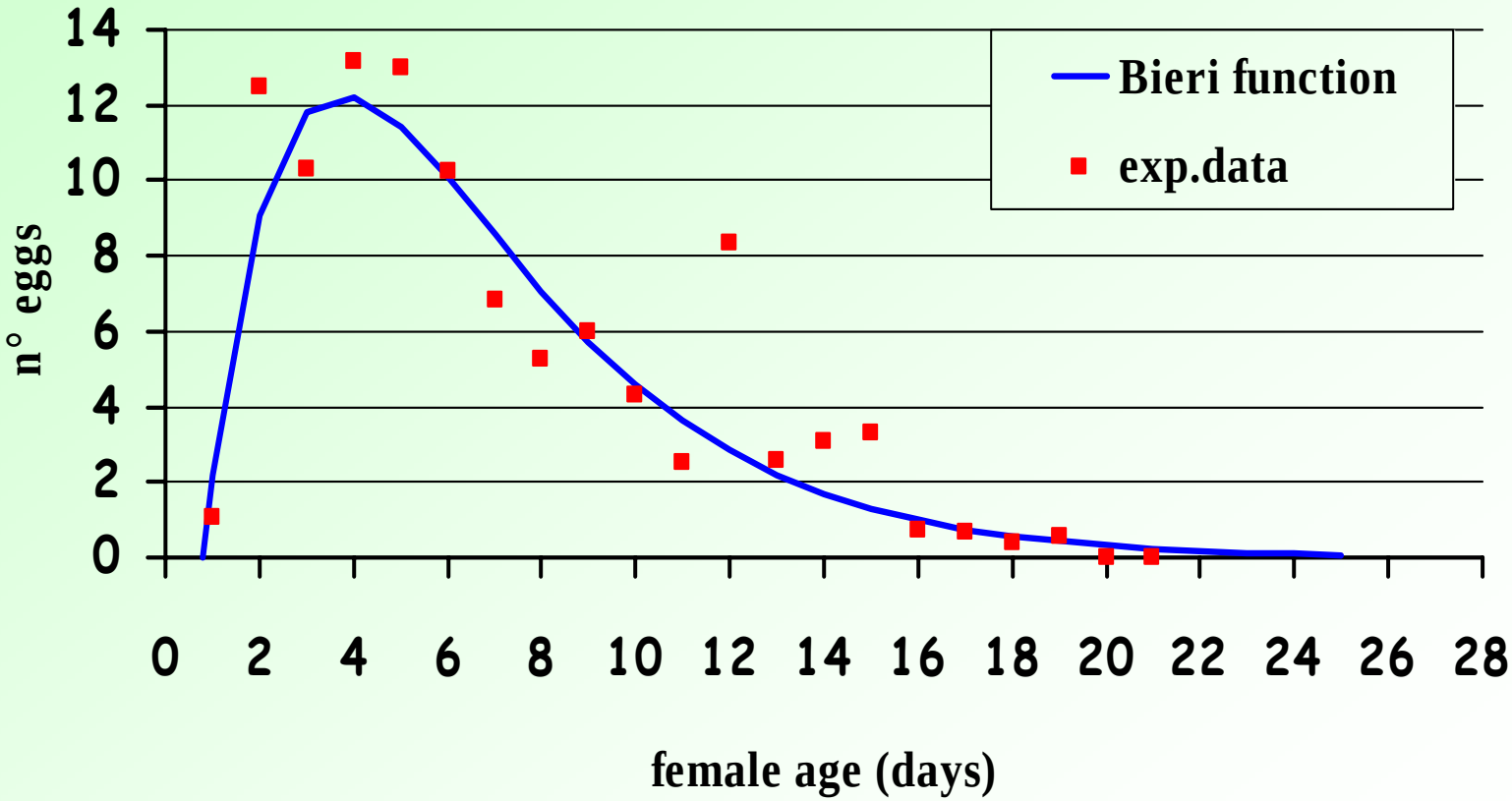
Age-depending Femal mean fecundity of *Lobesia botrana*



PEST BREEDING CONDITION FOR THE ESTIMATE OF THE BIOLOGICAL PARAMETERS

- larvae collected in the field
- breeding larvae on natural diet
- adults feeded with water and honey
- individual breeding system
- daily check
- Temp from 12 to 35°C (at least 5 temp.)
- R.H. 70%
- photoperiod 17/7 L/D

Time Delay simulation model

Initialization 100% of overwintering population (1° january)

Input hourly or bi-hourly temperature

Elaboration - calculation of istantaneous development (Logan function, retta)

- calculation of the age-depending fecundity (Bieri function)

- application of the TD model simulation

Output - % individuals in each different phenological phase

- % individuals reaching each phenological phase

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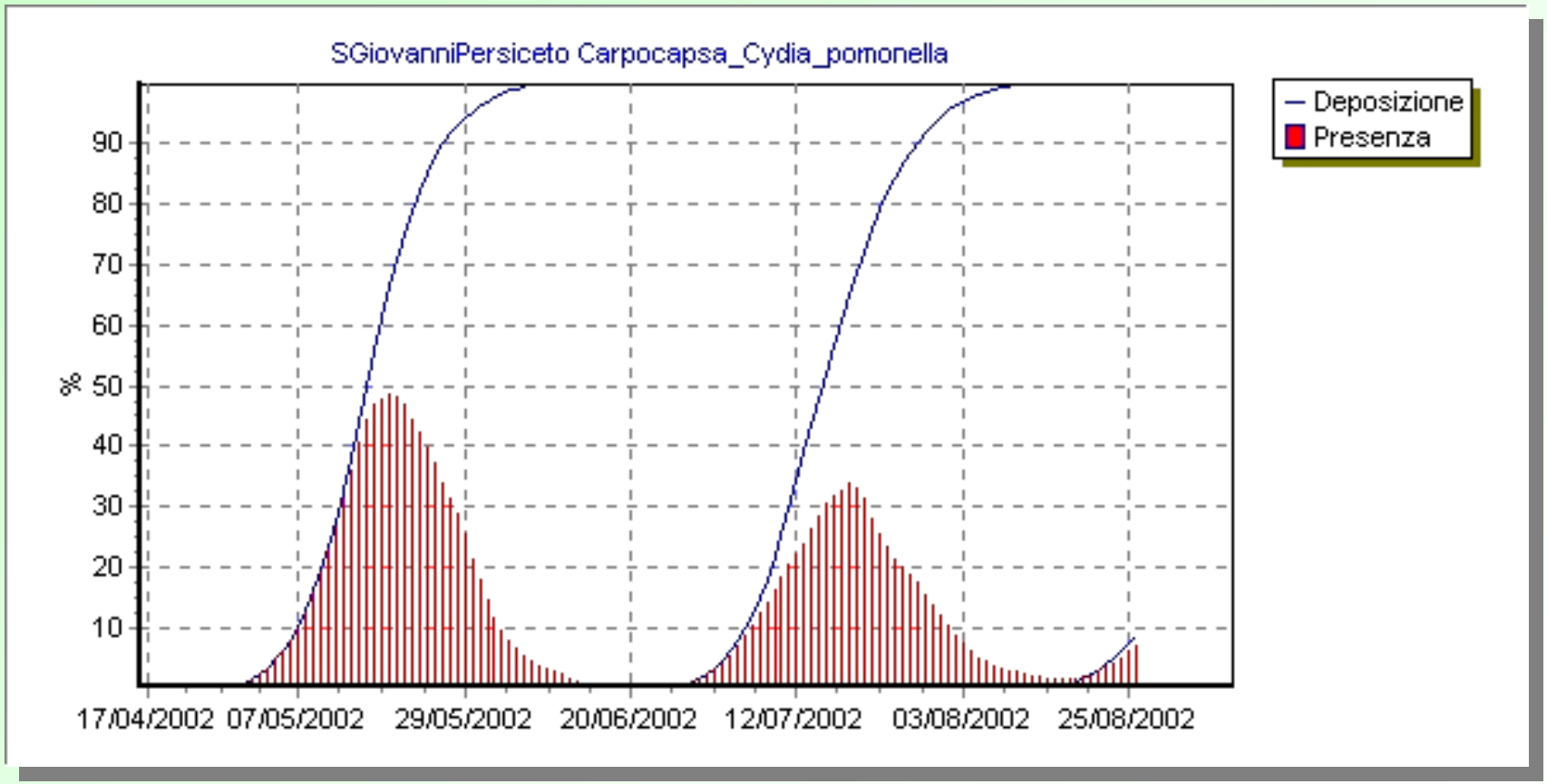
Cydia pomonella – Graphic Output



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Results of TD model simulation on *Lobesia botrana* in Correggio(RE) in 2002

Lobesia botrana	EGGS			LARVAE			PUPAE			ADULTS		
	Gen	Cum	Per	Gen	Cum	Per	Gen	Cum	Per	Gen	Cum	Per
01/07/02	2	38	21	2	17	20	1	97	22	1	75	68
02/07/02	2	42	22	2	21	23	1	98	19	1	79	70
03/07/02	2	47	22	2	24	26	1	98	16	1	83	71
04/07/02	2	51	23	2	28	29	1	99	13	1	86	72
05/07/02	2	55	23	2	32	33	1	99	11	1	88	72
06/07/02	2	59	23	2	36	36	1	100	10	1	90	71
07/07/02	2	62	22	2	40	40			8	1	92	70
08/07/02	2	66	22	2	44	43			7	1	93	68
09/07/02	2	69	21	2	48	47			6	1	95	66
10/07/02	2	73	20	2	53	51	2	1	6	1	96	63
11/07/02	2	76	19	2	57	55	2	2	5	1	97	61
12/07/02	2	79	18	2	61	59	2	2	5	1	98	58
13/07/02	2	82	16	2	65	62	2	3	5	1	98	54

Gen = *Generation*
Cum = *cumulative percentage of individuals over the total amount of population in each different phenological phase.*
***Pre* = percentage of individuals in each specific phenological phase (eggs, larvae, pupae and adults**

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MODEL VALIDATION

COMPARISON BETWEEN EXPECTED FLIGHT AND REAL FLIGHT MONITORED BY PHEROMONE TRAPS

ADVANTAGES

* low cost (farm monitoring performed by field technicians)
* many data in short time

CONSTRAINTS

* variability in traps efficacy (number of male catches vs. male real presence) due to several factors affecting the flight (male age, competion of the females, weather conditions)

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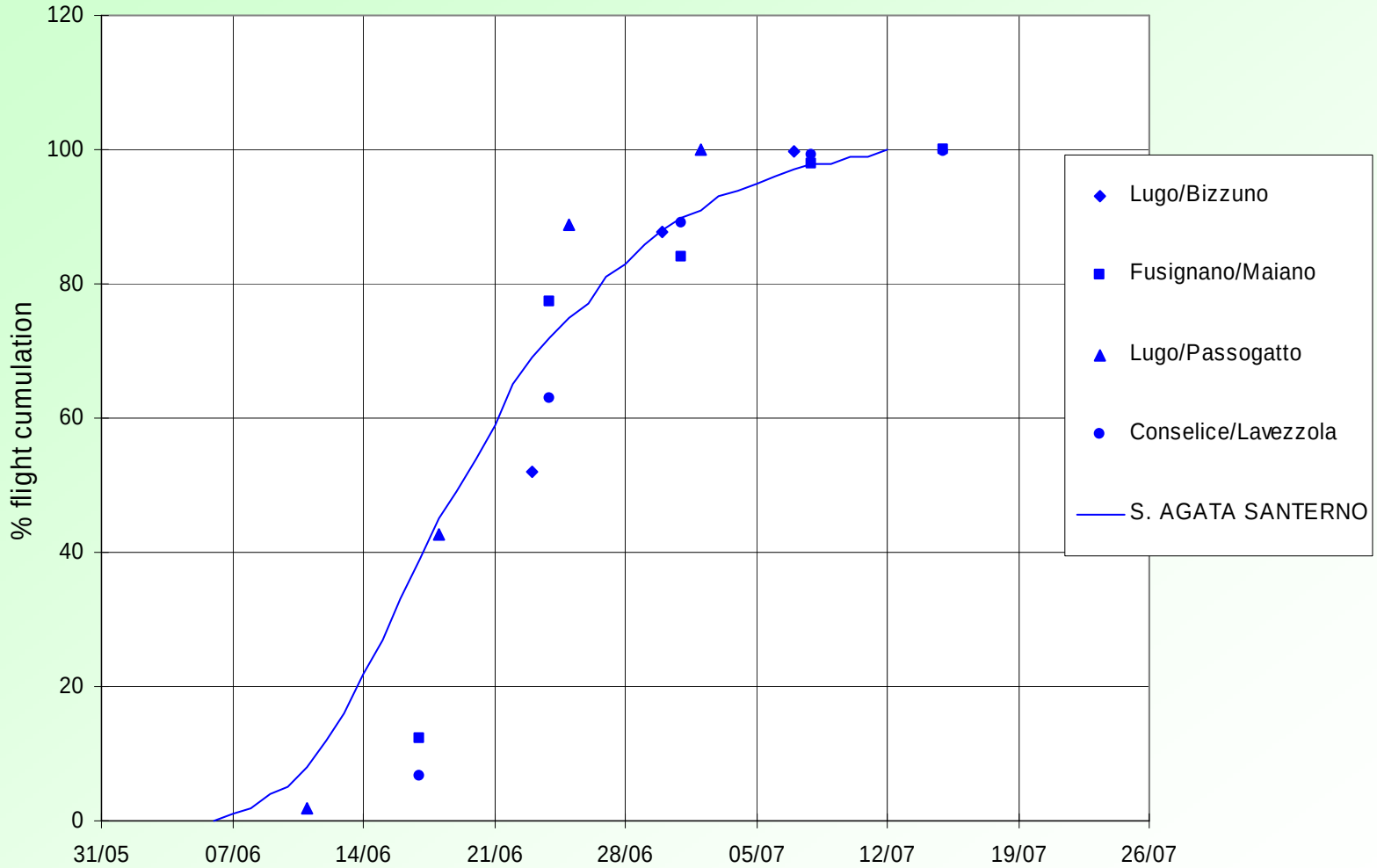
LOBESIA BOTRANA - RAVENNA 1997

II flight



MODEL VALIDATION

EXPECTED VS. OBSERVED EGG-LAYING

(Method adopted for *Cydia pomonella* e *Cydia funebrana*)

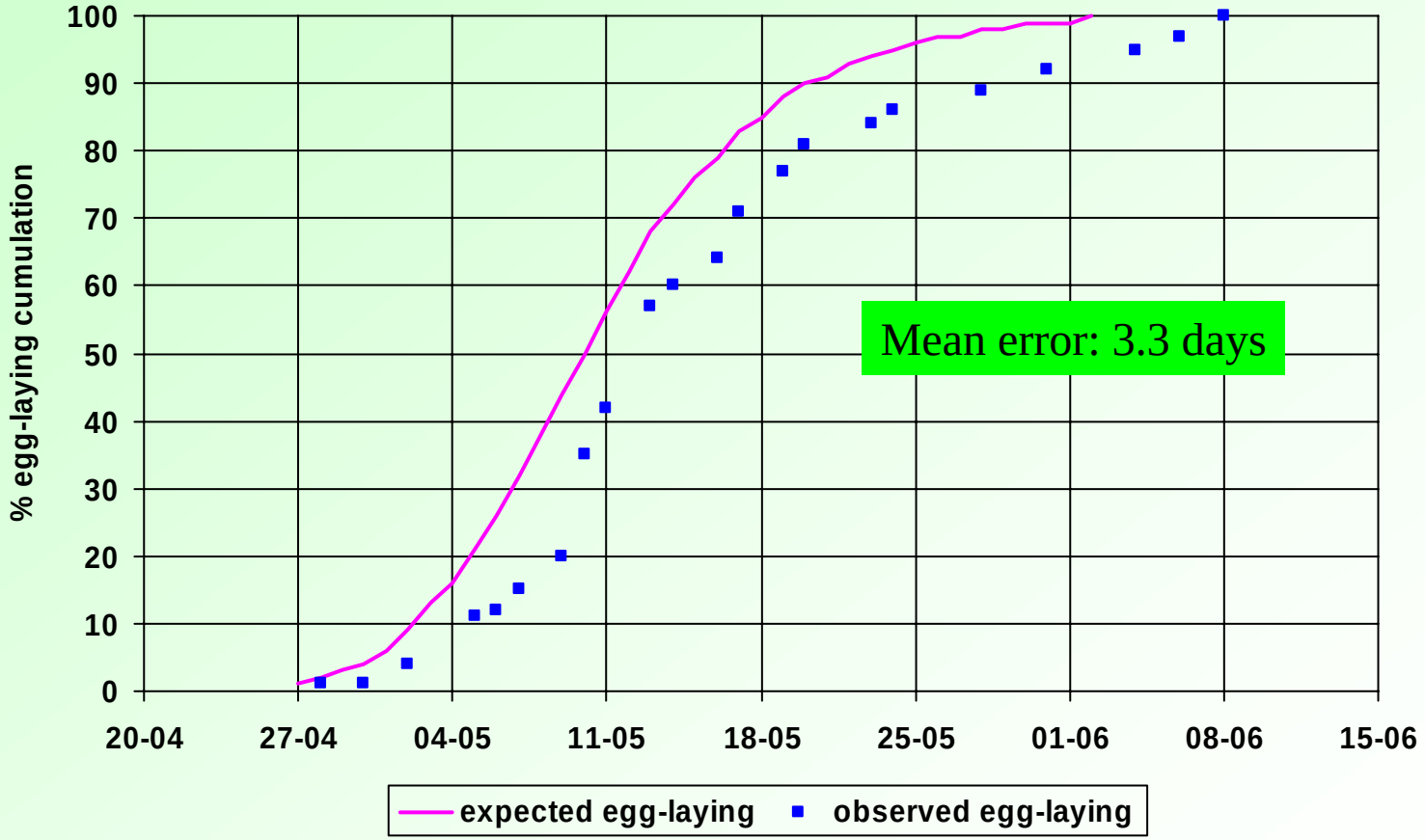
advantages

* Focusing on phenological phase commonly affected by chemical sprays (eggs or 1st age larvae)
* Results are more reliable

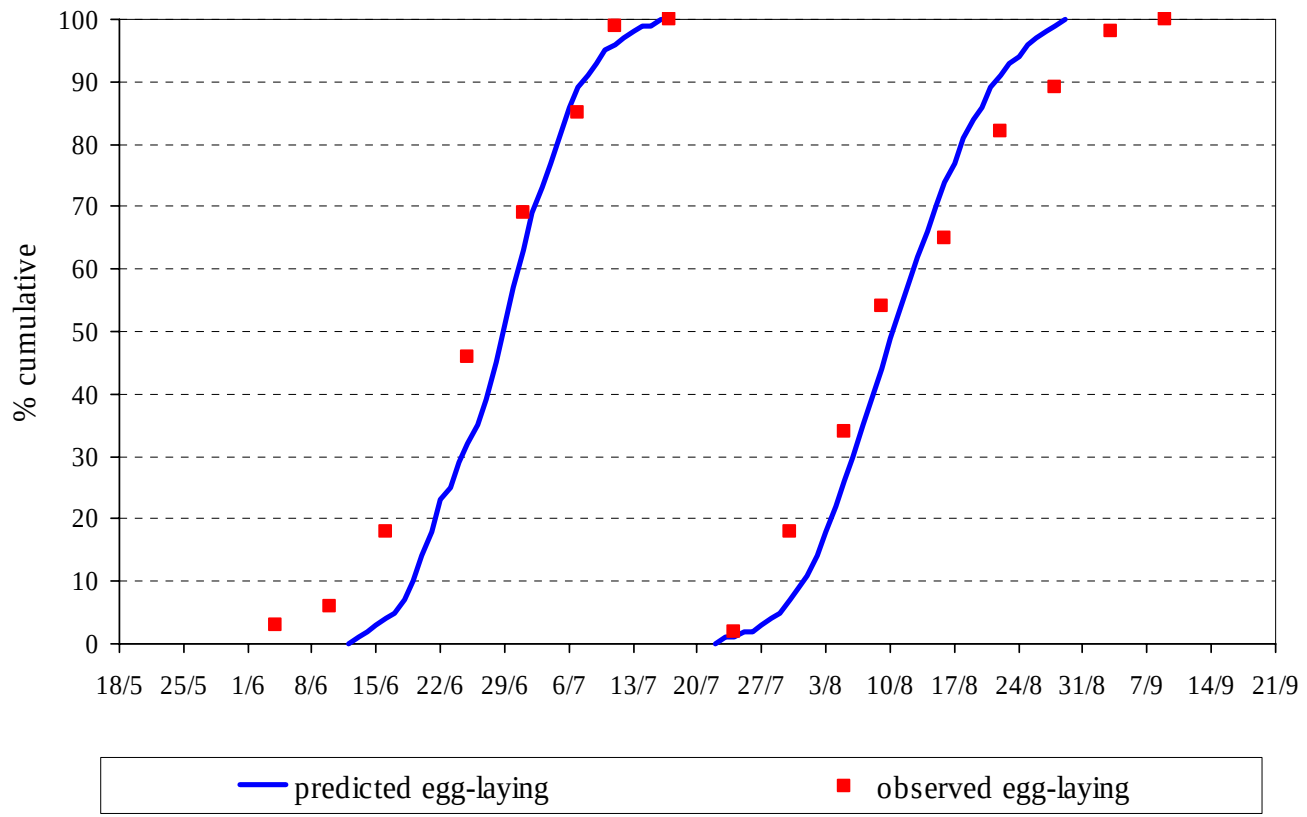
constraints

* expensive
* Few cases

Codling moth – 1st generation
S. Giovanni in Persiceto - 2000



Cydia funebrana – 2nd & 3rd generation
Sorrivoli (FC) - 1996



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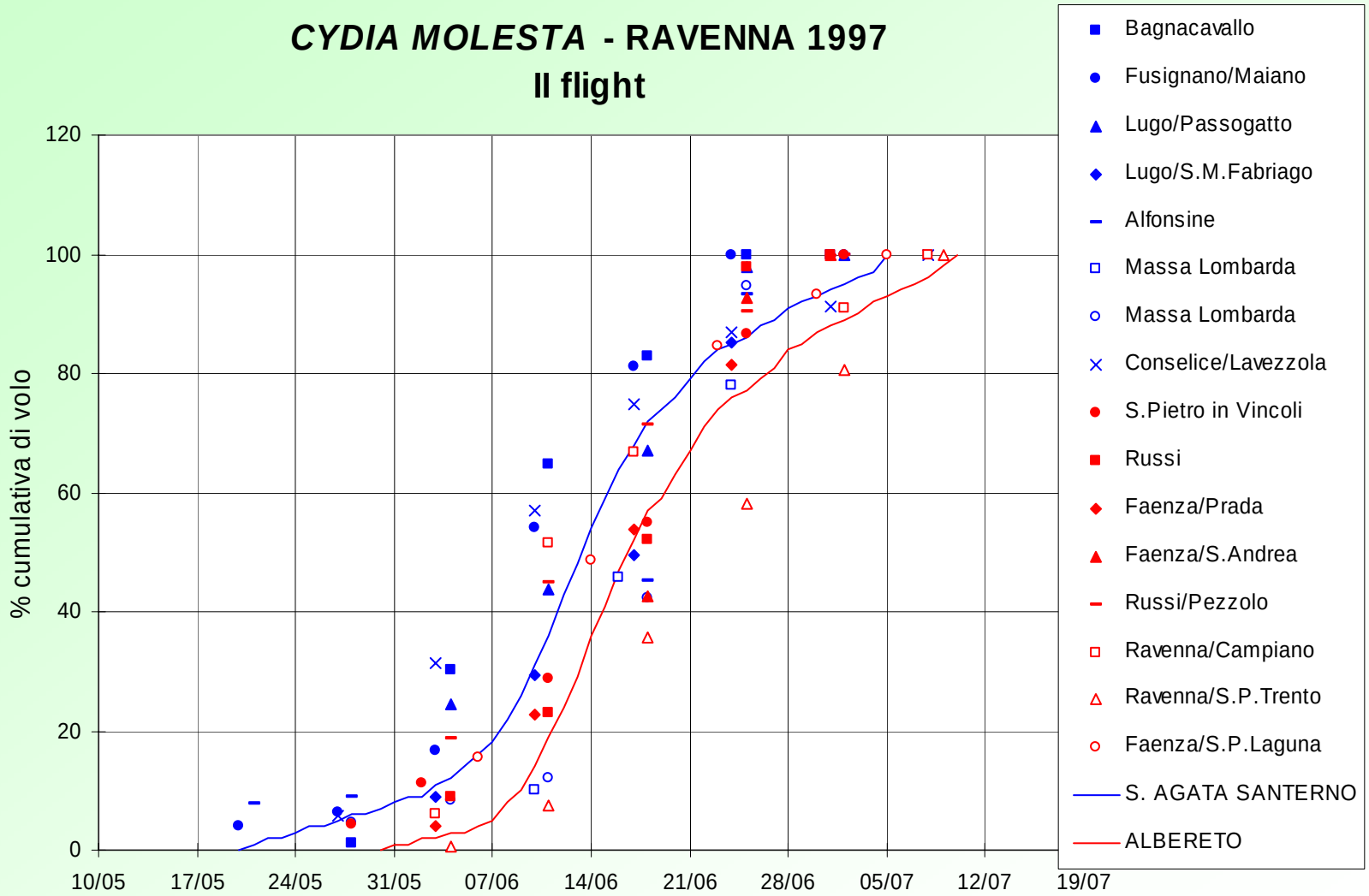
Check of model reliability

Information exchange between field technicians and Plant Protection extension

Overall evaluation of the system through expected and observed flight curves comparison

Specific monitoring in the most critical situations (Codling moth)

TD-model application on oriental fruit moth expected flight vs. observed flight



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Model check on Codling moth by egg monitoring S. Giovanni in Persiceto - 2002